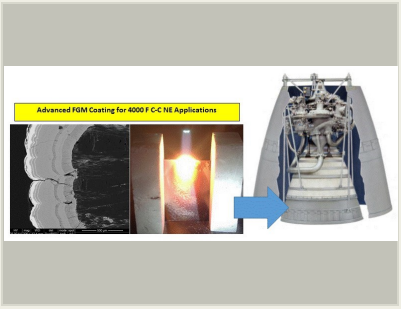
Novel, Functionally Graded Coating System for Reusable, Very High Temperature Applications, Phase II

Completed Technology Project (2017 - 2019)

Project Introduction

There is a clear need to advance the state-of-the-art carbon-carbon coated Nozzle Extensions (NE) beyond the engine/mission performance currently established by Herakles technology, which is intrinsically limited to about 3000 F. The well-established SiC-based (CVD, pack cementation) technologies currently available also have upper temperature limits around 3000 F, imposing stringent limitations on increased performance and system level changes (i.e. hotter propellant) for future NASA missions. In addition, the intrinsic CTE mismatch between C-C substrate and refractory carbides/oxides further limits the use of many other classical coating technologies. The successful Phase I results established the feasibility of overcoming these limitations through the use of a novel, functionally graded (FGM) coating technology. The proposed Phase II builds on the success of the Phase I program and clearly increases its TRL by offering subscale component testing at representative engine conditions. A successful Phase II program will clearly offer a new dimension in the nozzle extensions by offering different coating systems for multi-cycle capability at temperatures from 3000 F up to 4000 F. The expected ability of the coating to survive such an aggressive testing combined with the sufficient retention of mechanical properties offers a direct path for a Phase III with many of the commercial space payload companies. The overall approach is based upon a multi-piece C-C NE concept, which focuses the requirements for high temperature oxidation protection to smaller diameters of the nozzle extension (e.g. A cone), allowing the CVD coating technology to remain within current SOTA CVD capabilities. Larger diameter segments, which are exposed to lower temperatures, will utilize non-CVD lower cost technology which is well suited for large diameter components. The direct benefit to NASA is undisputed with direct applicability to several planned future missions, including the very challeng



Novel, Functionally Graded Coating System for Reusable, Very High Temperature Applications, Phase II Briefing Chart Image

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Small Business Innovation Research/Small Business Tech Transfer

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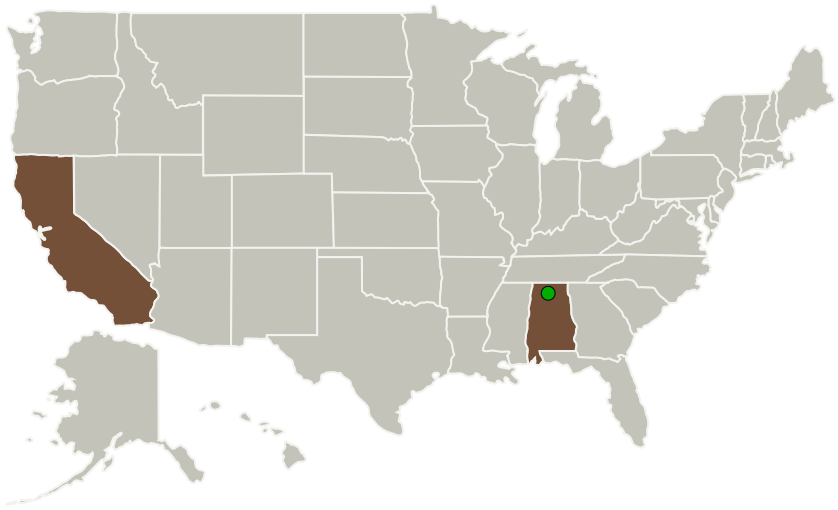
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Allcomp Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	California

Project Transitions

May 2017: Project Start

December 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141135)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Allcomp Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

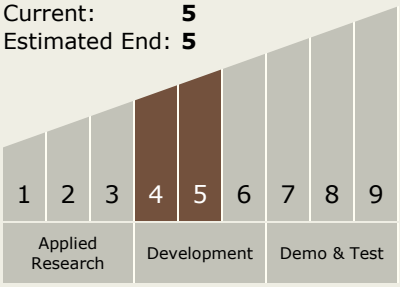
Carlos Torrez

Principal Investigator:

Steve Jones

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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Images

Briefing Chart Image
Novel, Functionally Graded Coating System for Reusable, Very High Temperature Applications, Phase II Briefing Chart Image
(https://techport.nasa.gov/image/132072)

Final Summary Chart Image
Novel, Functionally Graded Coating System for Reusable, Very High Temperature Applications, Phase II
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Final Summary Chart Image
Novel, Functionally Graded Coating System for Reusable, Very High Temperature Applications, Phase II
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Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.2 Structures
    - TX12.2.1 Lightweight Concepts

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System